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Product Note 30

Ultra Wideband Tuner System UTS

UTS is a new tuner family that inherently covers a maximum to minimum frequency of operation of up to 50:1 (≈ 6 octaves). It uses a new, balanced dual vertical axis, concept to precisely position and control two beryllium copper probes inside a wideband transmission slabline. UTS tuners are manufactured for 0.4 or 0.6 to 18 GHz, 1 to 26.5 GHz, 1 to 40 GHz and 1 to 50 GHz(). Main applications are in wideband and on-wafer Load Pull and Noise test systems.

Introduction

Wideband Load Pull and Noise characterization of existing and newly developed devices (FETs, HEMTs, HBTs etc) is as important as S-parameter measurements have been in the past.

Especially wideband on wafer probing of new chips yields key information on the quality of the process.

Existing Load Pull and Noise systems are limited in frequency bandwidth due to the components used, such as test fixtures (wafer probes), tuners, isolators and bias tees, couplers, attenuators, switches and filters (figure 1).

In load pull and noise measurements the core of the setup (probes, tuners and bias tees) must remain fixed when changing test frequency ranges in order to keep calibration data valid. Breaking and making connections in this section of the setup results in additional, sometimes critical, calibration and measurement errors. This is particularly true for on-wafer tests. It results that these components must be inherently wideband. Isolators are placed on the outside of the tuning section of the setup and can therefore be remotely controlled and replaced without significant measurement error. Wafer probes and bias tees are available with instantaneous frequency bandwidth from very low frequencies ($\approx DC$) to 40 or 50 GHz. Existing mechanical tuners though have instantaneous maximum bandwidth limited to 1 decade (0.8 to 8 GHz, 1.8 to 18 GHz) or less (4 to 26.5 GHz or 6 to 40 GHz). The new UTS therefore fully matches the bandwidth capability of the other much less sophisticated components of the setup.

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Tuner description

The Ultra wideband Tuner System (UTS, figure 1) employs a new concept in the construction of wideband mechanical tuners: It is based on a movement mechanism with one horizontal and two vertical axis placed balanced and diametral in the same wideband transmission line (slab-line). The horizontal and the two vertical axis are driven by 4-phase 1.8° stepping motors. The transmission line uses hard aluminum as bulk material and is precisely slotted over the whole length of 9" (1 to 40 GHz, 1 to 50 GHz) or 13.5" (0.4 or 0.6 to 18 GHz) with a tolerance of 0.0005" using wire-EDM. The width of the K®-slabline is 0.091" and for the 2.4mm 0.072". Residual return loss of the slablines is between 22 and 35 dB. Two metallic probes (slugs) made of Beryllium Copper, dielectrically coated on the bottom and axially slotted for good ground contact and low Microphonics, are mount one on each vertical axis. The vertical mechanisms control the position of the probes with a step resolution of 2.5µm and an accuracy of ±1 step. Each probe generates reflection in a different frequency range: The larger one (L=0.835") covers 1 to 5 GHz and the smaller one (L=0.125") covers 5 to 40 (50) GHz. Other UTS models use other sizes of slabline slots and probes to cover 0.6 to 18 GHz and 1 to 26.5 GHz. UTS tuners use different connectors and horizontal step size (phase resolution) depending on the highest operation frequency (table 1).

Model	Frequency Range	Connector	Horiz Resolution
UTS-1804	0.4 - 18 GHz	7 mm	25.4µm
UTS-1806	0.6 - 18 GHz	7 mm	25.4µm
UTS-1808	0.8 - 18 GHz	7 mm	25.4µm
UTS-2601	1.0 - 26.5 GHz	3.5 mm	12.7µm
UTS-4001	1.0 - 40 GHz	2.9 mm (K®)	6.3µm
UTS-5001(□)	1.0 - 50 GHz	2.4 mm	6.3µm

Table 1: Members of the UTS tuner family

UTS tuners are designed for reduced weight in order to minimize stress on the probe stations when used in on-wafer testing. A UTS-4001 weighs 3kg compared with 4kg of a CCMT-1816 (1.6 to 18GHz) and 5.1kg of a CCMT-1808, despite the fact that UTS utilizes two distinct vertical movement mechanisms instead of one in the CCMT[1].

UTS tuners are employed in automated Load Pull and Noise setups for highest instantaneous bandwidth (figures 5 and 7, table 1). Other key advantages inherent to this type of tuning device are:

- 1- Practically unlimited power handling capability (50W CW, >1kW Peak)
- 2- Low insertion loss (0.3dB at $\Gamma=0$ and 2 to 4 dB at $\Gamma\approx 0.9$). This allows to drive the transistors hard into saturation without need for very high power sources.
- 3- Low pass behaviour (the tuners present 50Ω to the DUT at frequencies below the minimum operation frequency, thus eliminating most spurious oscillations).

UTS Specifications

Frequency Range	0.4 to 50 GHz (see table 1)
VSWR range	Min< 1.15:1, Max: >10:1
Maximum Tuning Resolution @ Γ_{\max}	0.2° to 0.6° at f_{\max}
Number of tuneable Points @ f_{\max}	\approx 800,000 to 11,000,000
Power Handling	40-100W CW, >1kW peak
RF-Resetability of Γ	> 40dB

Table 2: Key specifications of UTS tuners